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Cbeta Arc Lattice Status with Iron Magnets

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Cbeta Collaboration Meeting
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Status at Previous Meeting

- Had a 250 MeV design for iron magnets, with field maps
  - Matched hard-edge design well
  - Some corrections required
    - Magnet relative displacement reduced by about 5 mm
    - Different scaling factors apply to F and D (different lengths)
  - Required a zig-zag vacuum chamber
- Wanted some changes
  - Smooth vacuum chamber (no corners)
    - Requires increase in magnet aperture
  - Allowed to go down to 200 MeV

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Subsequent Activity and Changes

- 200 MeV lattice created, very tight margins on magnets
- Works with smooth beam pipe
- New requirements added
  - Lower horizontal tune (more margin at low energy)
  - Fix arc cell at 5 degrees
    - Needed slightly larger radius for this
  - Have 200 MeV lattices meeting these requirements (margins still tight)

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Magnet Margin: Energy

- Desire to have more magnet margin
  - Engineering margin for permanent magnet assembly
  - Field in pole was very high
- Chose energy reduction
  - Initially 166 MeV, which addressed the issues
  - Some expressed a desire to go down to 150 MeV, and that is what I am currently working with

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Design Status

- Now have a slightly different design path from before
  - Start with initial hard edge design
    - This fixes the geometry (except displacements)
  - Generate field maps, iterate corrections
    - Initial guess is really close at this point
  - Generate hard edge design that matches field map result
    - Avoids geometry adjustment to close the loop
- Have 150 MeV design with fieldmaps
  - At the sub-mm sub-% correction level
  - Based on 200 MeV back-yoke
  - Geometry chanages tiny even from 200 MeV

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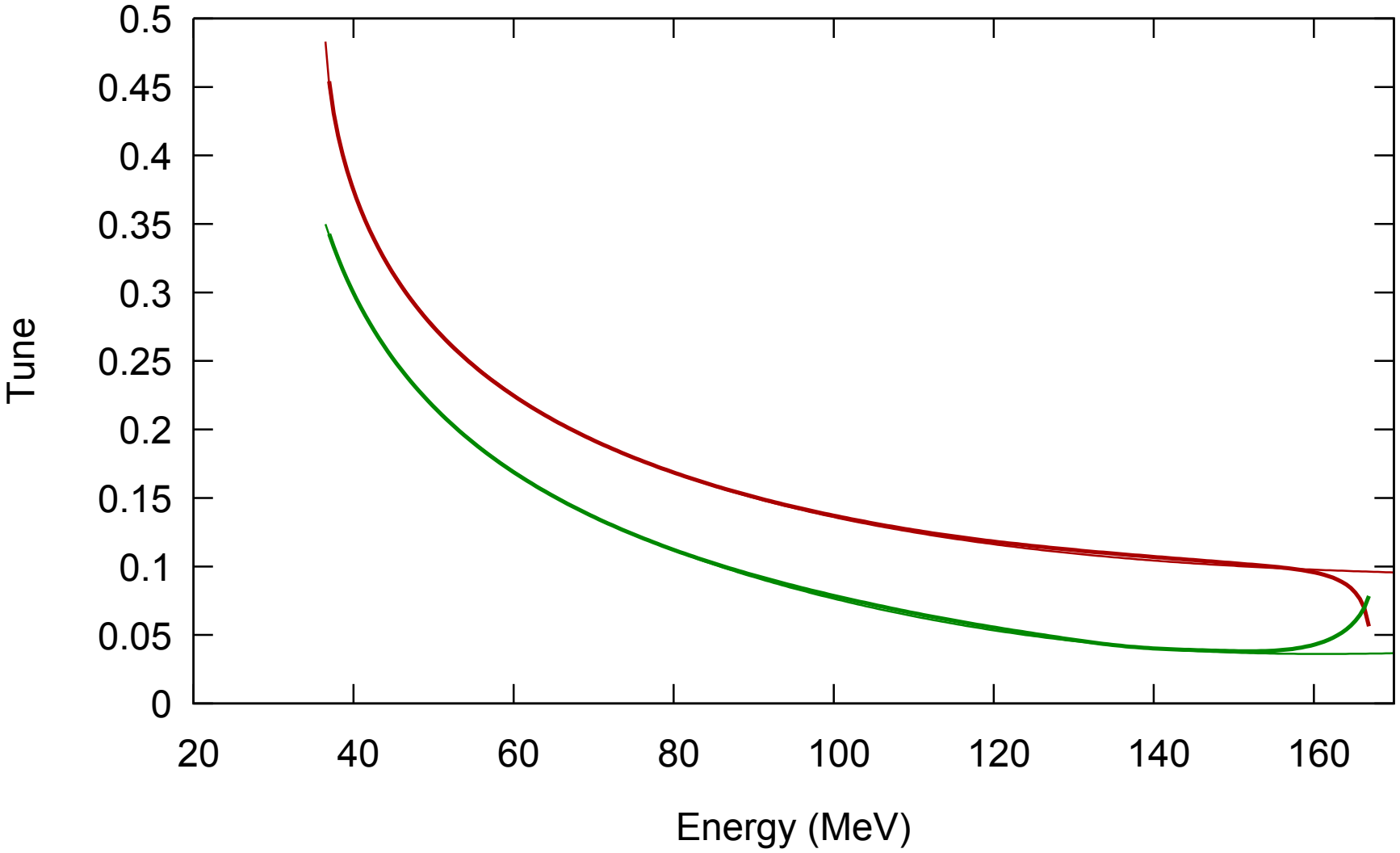
Tunes



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Tunes

- Extended the good field region a bit and pushed the nonlinearity in the positive direction to hold onto more margin at the high energy end
- Lowered horizontal tune may not be the best choice: it's the high energy end that is fussy
  - Factor of 4 paints you into a corner here
  - Nonetheless, everything looks very good

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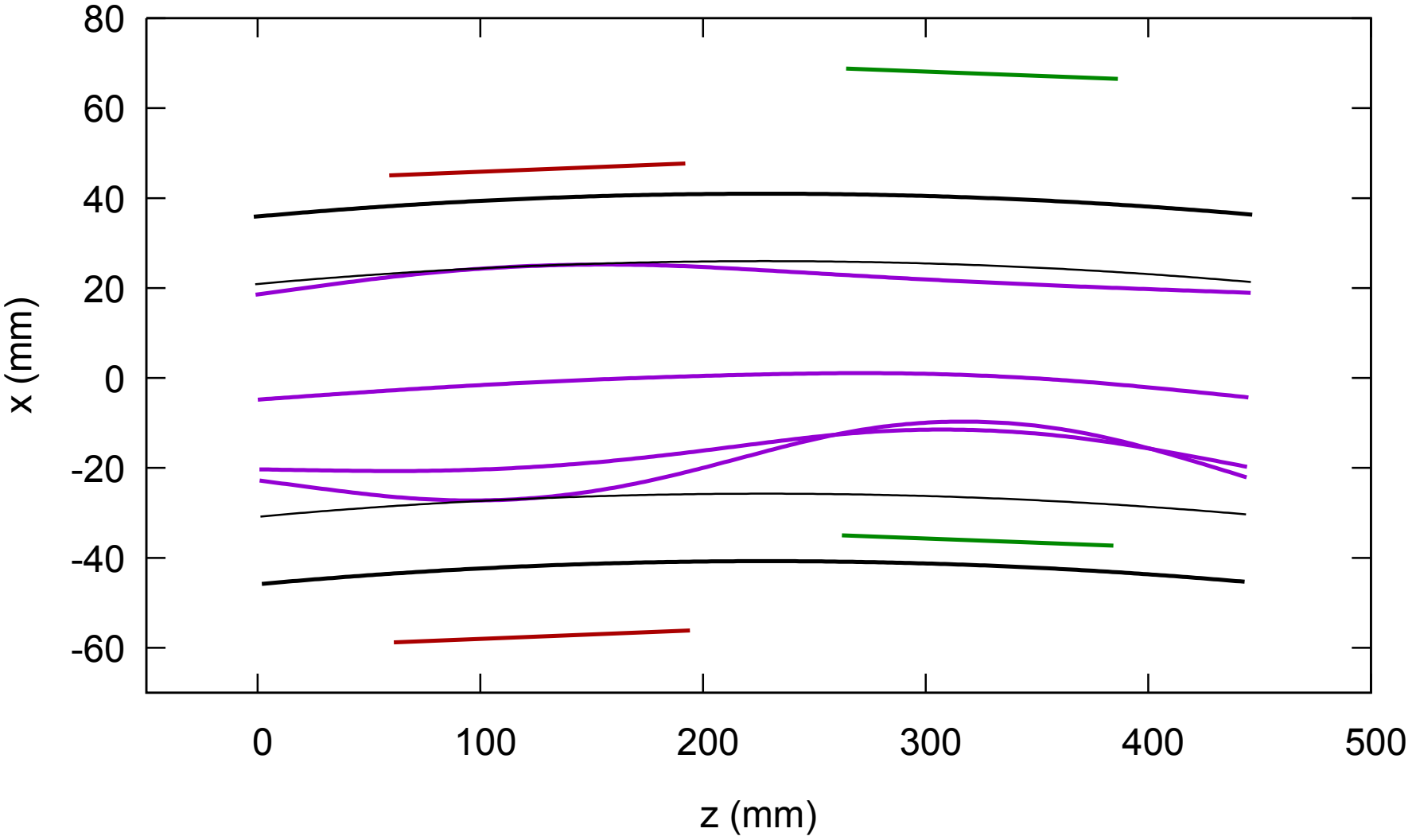
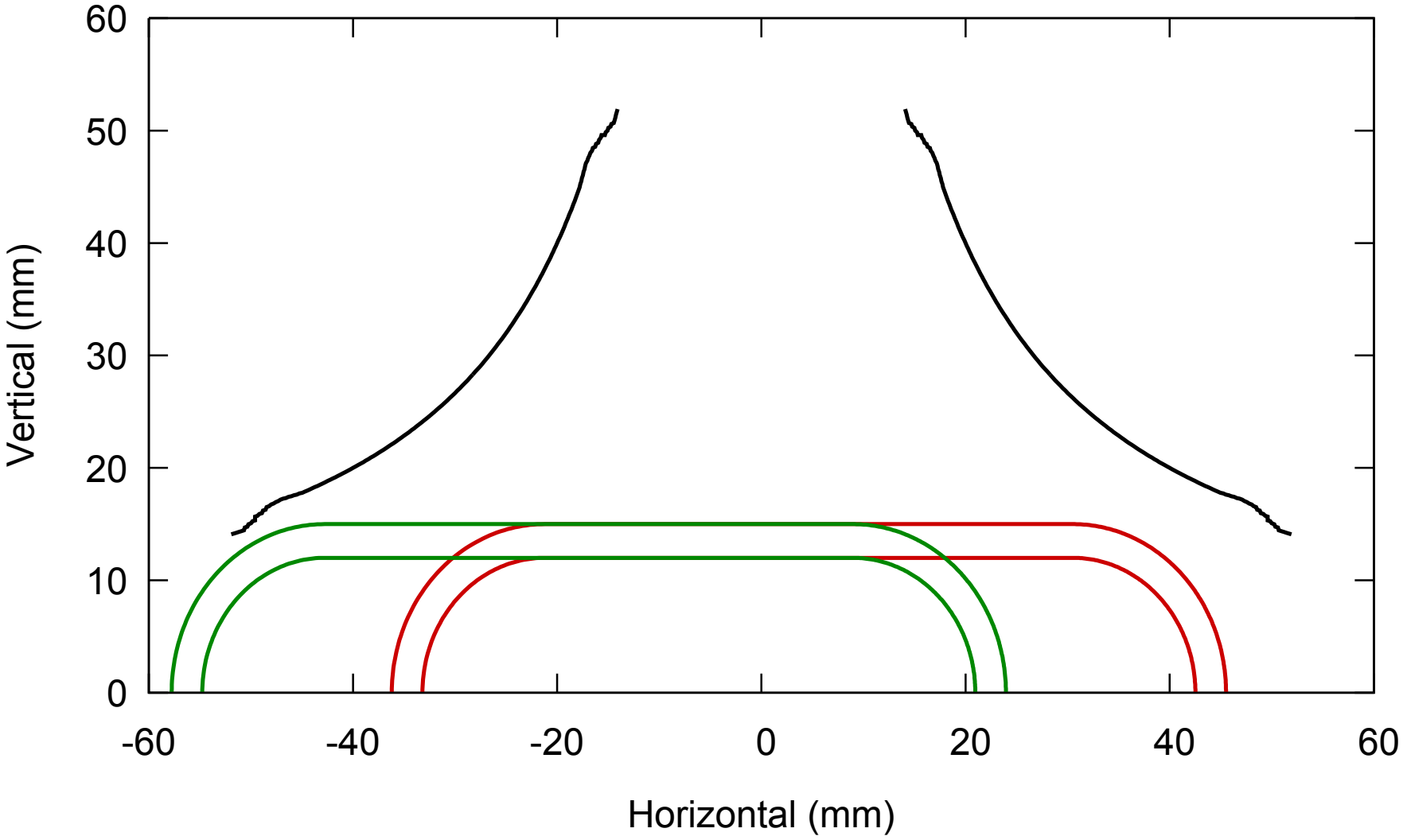
Fitting the Beam Pipe

- Smooth pipe comes close to inside D pole
- Required clearance to pipe determines minimum pole size
- Want to avoid growing magnet aperture
- Design specifically targets minimum aperture
- Succeeded in keeping clearance to beam with pipe inside poles
  - 2 mm of extra slop
  - From field map experience, I want that 2 mm to be able to deal with unexpected systematics in real magnets
- Have a “fat” pipe giving maximal vertical height
  - Needed to make BPM work with only 4 buttons

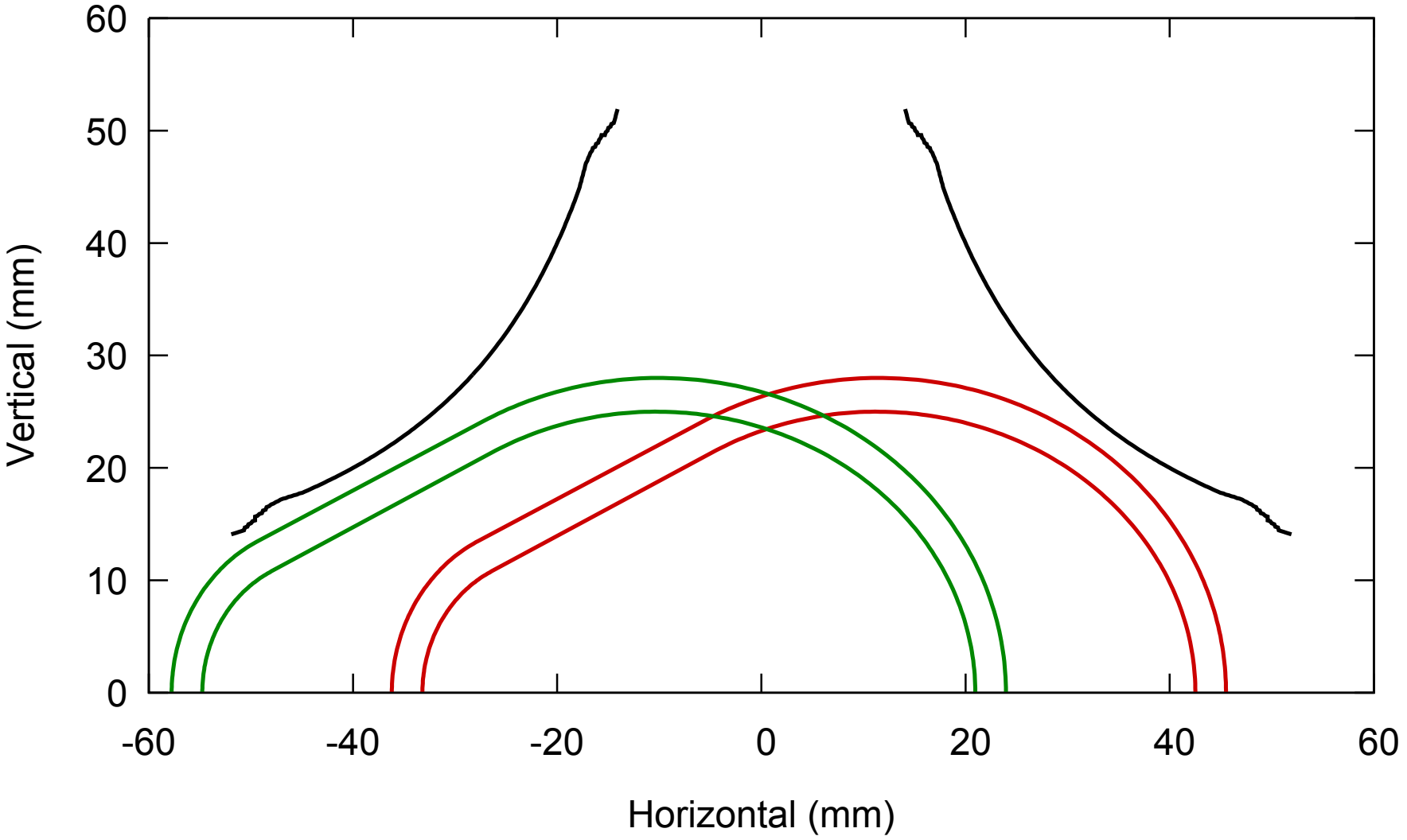
Orbits, Minimum Pipe



Minimum Pipe



Nearly Maximal Pipe



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Flat Chamber

- After discussions at BNL, we propose to use a flat chamber with 6–8 button BPMs
- Correctors
  - EMMA experience
    - Correction was hard
    - We wanted more correctors
    - Cbeta should be easier
  - Fat chamber prevents correctors in magnets
  - Concerns with correctors in drifts
    - Limited number of locations available
    - Strength
    - Interference from nearby iron?
    - Non-locality of correction as you approach full corrector set

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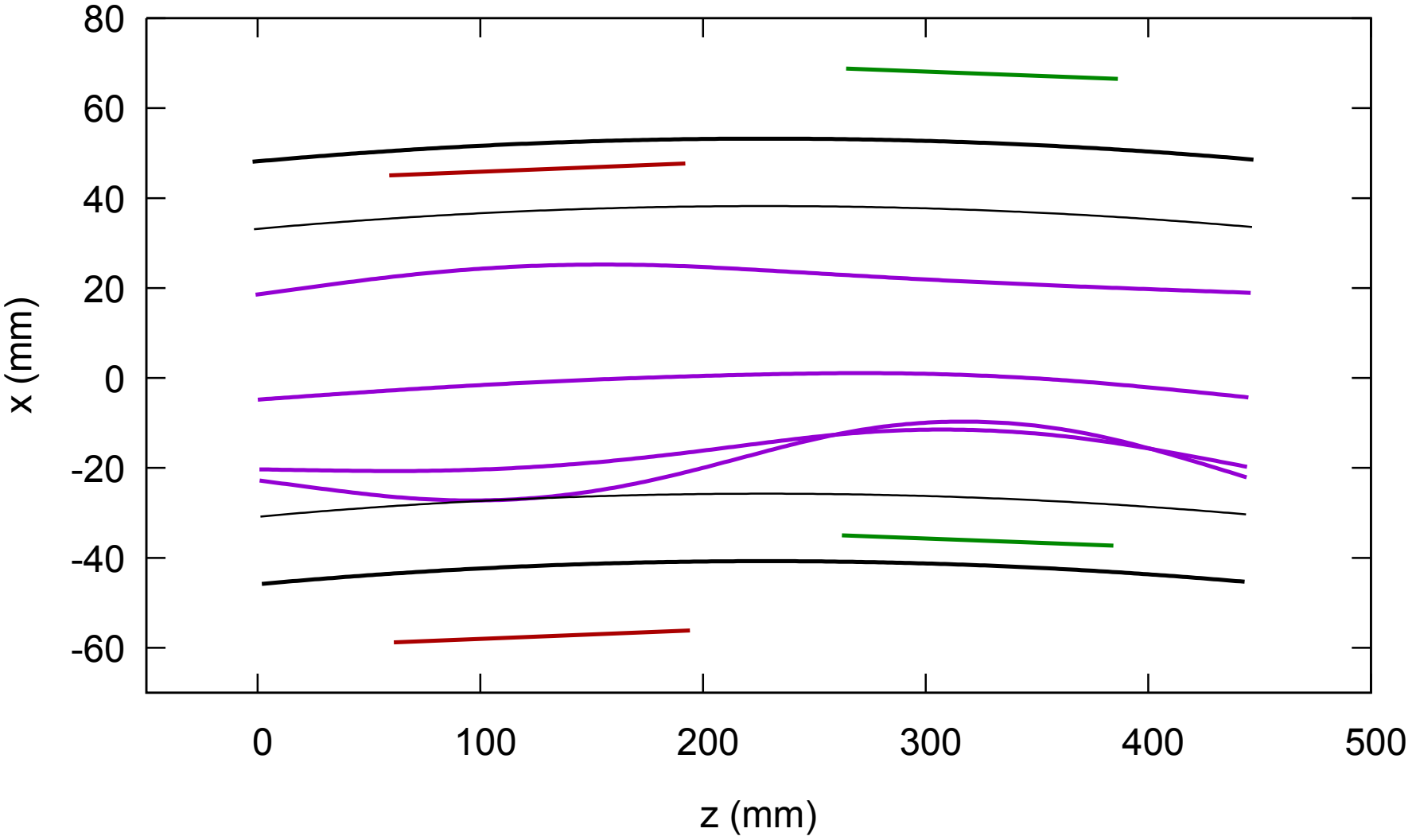
Flat Chamber

- BNL needs to do BPMs for flat chambers anyhow for eRHIC
- We are willing to commit to taking on the BPM system if need be

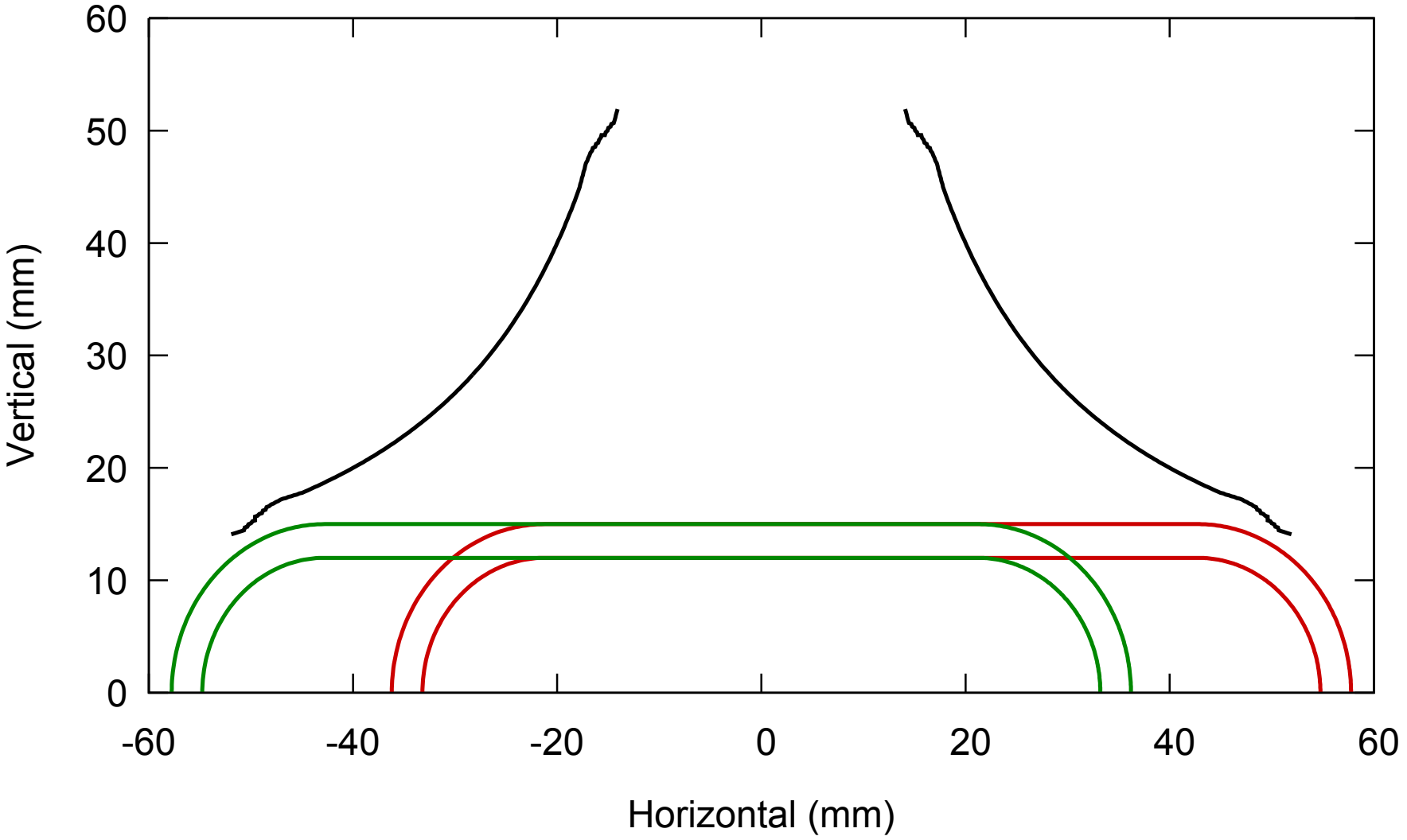
Wide Flat Pipe

- Minimal pipe: outer orbit is close to the outer edge
- Would rather have pipe go further outside the outer orbit
- There is room

Orbits: Wide Flat Pipe



Wide Flat Pipe



5° Design: Hard Edge

Maximum Energy (MeV)	150	
Reference Radius (m)	5.099439	
L_{DF} (mm)	120	
L_{FD} (mm)	70	
α	F	D
$L_{Q\alpha}$ (mm)	133	122
x_α (mm)	−7.472	+20.840
Gradient (T/m)	+10.225	−9.642
Δx_α for Maps (mm)	+3.235	−3.901

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Summary

- We can make lattices that work with field maps and allow a smooth beam pipe
  - Designs have been very stable
  - Have a good process that includes field maps
- 200 MeV pushes the magnets really hard
  - We propose going down to 166 MeV or 150 MeV. Both look fine.
- We (BNL) are proposing to use a flat vacuum chamber and 6–8 button BPMs
  - Allows dipole correctors in magnets
  - BNL will commit to making the BPM system happen